Beschäftigungseffekte der Digitalisierung

Carl Benedikt Frey
“Thou aimest high, Master Lee. Consider thou what the invention could do to my poor subjects. It would assuredly bring to them ruin by depriving them of employment, thus making them beggars” (cited in Acemoglu and Robinson, 2012, p. 182f).
<table>
<thead>
<tr>
<th></th>
<th>Plows</th>
<th>Muslin shirts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Artisan shop</td>
<td>Factory</td>
</tr>
<tr>
<td>Number of workers</td>
<td>2</td>
<td>52</td>
</tr>
<tr>
<td>Total hours per output</td>
<td>118</td>
<td>3.75</td>
</tr>
<tr>
<td>Number of tasks</td>
<td>11</td>
<td>97</td>
</tr>
</tbody>
</table>
Job polarization is evident across most industrial economies

Source: David Autor (2010), “The Polarisation of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings,” Center for American Progress and The Hamilton Project. Wage categories are based on average wage levels at the start of the period measured
Computers are increasingly a cheaper alternative to human work.

[The Hamilton Project, Brookings]
The scope of computerization is rapidly expanding

<table>
<thead>
<tr>
<th>Cognitive Routine</th>
<th>Nonroutine</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Record-keeping</td>
<td>• Medical diagnosis</td>
</tr>
<tr>
<td>• Calculation</td>
<td>• Legal writing</td>
</tr>
<tr>
<td>• Repetitive customer service (bank teller)</td>
<td>• Persuading selling</td>
</tr>
<tr>
<td></td>
<td>• Managing others</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Manual</td>
<td></td>
</tr>
<tr>
<td>• Picking or sorting</td>
<td>• Janitorial services</td>
</tr>
<tr>
<td>• Repetitive assembly</td>
<td>• Truck driving</td>
</tr>
</tbody>
</table>

Source: Autor, Levy and Murnane (2003)
We live in the age of big data.

All printed material in the world: 200 petabytes (2 x 10^{17} bytes)

All words ever spoken by human beings: 5 exabytes (5 x 10^{18} bytes)

Predicted internet traffic in 2015: 960 exabytes (1 x 10^{21} bytes)

Source: UC Berkeley School of Information, 2003; Cisco Visual Networking Index, 2011
Big data is leading to the automation of translation work
• Levy and Murnane (2004): “executing a left turn against oncoming traffic involves so many factors that it is hard to imagine discovering the set of rules that can replicate a driver's behaviour”.

• In 2012, Nevada issued a driving license to a fully autonomous Google car.
The QC-Bot is automating logistics in hospitals, delivering medicines, materials and meals.
Essentially all **logistics tasks** are imminently automatable; we will see autonomous
So, if machines can drive, serve customers, and look through data as well as humans, what are humans still good for? In short, creativity and social intelligence.
Autonomous manipulation is also hard, largely due to the difficulties involved in perception.

Nonetheless, some construction, truck-loading and shelf-stacking tasks may be automated.
Unstructured environments are also difficult to automate: warehouses, hospitals and airports are likely to host automated workers long before the home or office.
We expect social intelligence, creativity and perception to be **bottlenecks to computerisation**.

We used a dataset of 702 occupations, giving job features (e.g. requirements for finger dexterity and persuasion) to **predict automatability by 2030**.
USA
We predict that high-skilled jobs are relatively resistant to computerisation.
8 of the 10 occupational categories with the highest proportion of new job types that did not exist in 1990 were directly related to computer technologies.

<table>
<thead>
<tr>
<th>Categories</th>
<th>New job types (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Software Engineers</td>
<td>80.0</td>
</tr>
<tr>
<td>Database Administrators</td>
<td>78.6</td>
</tr>
<tr>
<td>Network and Computer Systems Administrators</td>
<td>78.1</td>
</tr>
<tr>
<td>Computer and Information Systems Managers</td>
<td>76.5</td>
</tr>
<tr>
<td>Computer Support Specialists</td>
<td>71.4</td>
</tr>
<tr>
<td>Computer Programmers</td>
<td>59.1</td>
</tr>
<tr>
<td>Miscellaneous Personal Appearance Workers</td>
<td>50.0</td>
</tr>
<tr>
<td>Logisticians</td>
<td>50.0</td>
</tr>
<tr>
<td>Computer Hardware Engineers</td>
<td>50.0</td>
</tr>
<tr>
<td>Physical Therapists</td>
<td>50.0</td>
</tr>
</tbody>
</table>
New Industries have emerged

<table>
<thead>
<tr>
<th>Detailed industry</th>
<th>% of US Employment</th>
<th>% with college degree</th>
<th>Avg. Wages ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet publishing and broadcasting</td>
<td>0.06</td>
<td>69.6</td>
<td>81,138</td>
</tr>
<tr>
<td>Electronic shopping</td>
<td>0.08</td>
<td>49.7</td>
<td>45,372</td>
</tr>
<tr>
<td>Data processing, hosting, and related services</td>
<td>0.08</td>
<td>48.0</td>
<td>64,729</td>
</tr>
<tr>
<td>Electronic auctions</td>
<td>0.01</td>
<td>52.2</td>
<td>47,257</td>
</tr>
</tbody>
</table>

0.5 % of the US workforce is employed in new industries created in the 21st century

Source: Berger & Frey (2014)
Skills and the Concentration of New Industries

Source: Berger & Frey (2014)
The Computer Revolution and the **Shifting Fortunes** of US Cities

Source: Berger & Frey (2014)
New jobs are emerging

1. **The iOS Developer**
   - Apple announced the iPhone in 2007, and 3rd party development for iOS took off in 2008 with the release of iOS 2 and the App Store.
   - 2008: 89
   - 2013: 12,634
   - 142x growth in 5 years

2. **The Android Developer**
   - Google's Android platform was also announced in 2007, with the release of the first Android-powered handset in 2008.
   - 2008: 53
   - 2013: 10,554
   - 199x growth in 5 years

3. **The Zumba Instructor**
   - Zumba started in the early 2000s and quickly gained traction in 2007 as fitness centers started popping up all over the US.
   - 2008: 16
   - 2013: 6,331
   - 396x growth in 5 years

4. **The Social Media Intern**
   - LinkedIn, Facebook, Youtube, and Twitter were all launched between 2003 and 2006. These networks really started hitting their stride after 2006 and are currently at peak popularity, not a career path.
   - 2008: 25
   - 2013: 4,350
   - 174x growth in 5 years

5. **The Data Scientist**
   - Our digital lives have created an overwhelming flood of information. In the last 5 years, data scientists have come to the rescue by trying to make sense of it all.
   - 2008: 142
   - 2013: 4,326
   - 30x growth in 5 years

6. **The UI/UX Designer**
   - User interface and user experience designers focus on making our technology pleasant and intuitive to use. Seeing as our lives depend on interacting with technology, it's no small wonder UI/UX designers are in high demand.
   - 2008: 159
   - 2013: 3,509
   - 22x growth in 5 years
New jobs are emerging

7. **The Big Data Architect**
   - Although it’s been around for at least 7 decades, the concept of big data took off around 2008. That year, the Computing Community Consortium published a white paper which propelled the term into the limelight.
   - **2008:** 0
   - **2013:** 3,440
   - **3,440 x growth in 5 years**

8. **The Beachbody Coach**
   - Beachbody coaches are distributors of fitness products produced by Beachbody LLC, the most famous of which is P90X, launched in 2004.
   - **2008:** 0
   - **2013:** 3,360
   - **3,360 x growth in 5 years**

9. **The Cloud Services Specialist**
   - Salesforce.com and Amazon are the 2 companies that introduced cloud computing to businesses throughout the early 2000s. This stark contrast in the number of jobs shows how popular and reliable cloud services have become.
   - **2008:** 195
   - **2013:** 3,314
   - **17x growth in 5 years**

10. **The Digital Marketing Specialist**
    - Social media and digital marketing have become significant facets of many businesses (and we’re pretty glad that’s the case!)
    - **2008:** 166
    - **2013:** 2,886
    - **17x growth in 5 years**